

What is claimed is:

1. A method of processing a variable-density image of a target object having a contour which includes straight-line portions, said image comprising edge pixels

5 representing said contour, said method comprising:

a line labeling step of setting a different one of labels to each of the directions of said straight-line portions;

a pixel labeling step of assigning to those of said edge pixels, which have the same direction as any one of the different directions of said straight-line portions, the same label assigned to said any one different direction; and

10 a line segment extracting step of extracting, as a line segment, an assembly consisting of those of said edge pixels which are continuous on said image and have a same one of said labels assigned thereto, said line labeling step, said pixel labeling step and said line segment extracting step being sequentially carried out.

15 2. The method of claim 1 wherein said line labeling step includes:

a histogram making step of preparing a histogram from numbers of edge pixels having different directions; and

20 a peak label setting step of extracting peaks from said histogram and setting a different label to each of the directions of edge pixels corresponding to a different one of the extracted peaks;

said histogram making step and said peak label setting step being carried out such that said labels are each set to one of directions of straight-line portions contained in said contour of said target object; and

25 wherein said pixel labeling step comprises the step of assigning each of the different labels set in said peak label setting step to each of the edge pixels having the direction corresponding to the each different label.

30 3. The method of claim 2 further comprising a unifying step, if the line segments extracted in said line segment extracting step include a pair with a positional displacement smaller than a specified maximum displacement value and a directional

difference smaller than a specified maximum directional difference value, of unifying said pair into a single unified segment.

4. The method of claim 2 further comprising a selecting step of selecting,
5 from the extracted line segments in said extracting, those of said line segments satisfying specified line segment selecting conditions.

5. The method of claim 3 further comprising a selecting step of selecting,
10 from the extracted line segments in said extracting step and from the unified line segments in said unifying step, those of said line segments satisfying specified line segment selecting conditions.

6. The method of claim 4 further comprising a display step of distinguishably
15 displaying on said image positions of the line segments selected in said selecting step.

7. The method of claim 5 further comprising a display step of distinguishably
displaying on said image positions of the line segments selected in said selecting step.

8. The method of claim 4 further comprising a display step of distinguishably
20 displaying on said image positions of crossing points of extensions of a plurality of the line segments selected in said selecting step.

9. The method of claim 5 further comprising a display step of distinguishably
25 displaying on said image positions of crossing points of extensions of a plurality of the line segments selected in said selecting step.

10. The method of claim 2 further comprising a defect detecting step of
30 determining whether a defect exists or not in straight-line portions of the contour of said target object by examining the line segments extracted in said line segment extracting step.

11. The method of claim 10 wherein it is determined in said defect detecting step, if there is a pair of line segments among the line segments extracted in said line segment extracting step, said pair of line segments having directions of which the difference is within a specified range and having a positional displacement within a specified limit, that there is a defect between said pair of line segments.

12. The method of claim 10 wherein it is determined in said defect detecting step that there is a defect in a straight-line portion of the contour of a target object by comparing the number of line segments extracted in said line segment extracting step with a specified standard value and if said number is different from said specified standard value.

13. The method of claim 1 wherein said line labeling step comprises setting a different one of said labels to each of expected directions of straight-line portions of the contour of said target object and said pixel labeling step comprises assigning said one label to those of the edge pixels having one of said expected directions.

14. The method of claim 13 further comprising a unifying step, if the line segments extracted in said line segment extracting step include a pair with a positional displacement smaller than a specified maximum displacement value and a directional difference smaller than a specified maximum directional difference value, of unifying said pair into a single unified segment.

15. The method of claim 13 further comprising a selecting step of selecting, from the extracted line segments in said extracting, those of said line segments satisfying specified line segment selecting conditions.

16. The method of claim 14 further comprising a selecting step of selecting, from the extracted line segments in said extracting step and from the unified line segments in said unifying step, those of said line segments satisfying specified line segment selecting conditions.

17. The method of claim 13 further comprising a defect detecting step of determining whether a defect exists or not in straight-line portions of the contour of said target object by examining the line segments extracted in said line segment extracting
5 step.

18. An image processing apparatus comprising:
image inputting means for inputting a variable-density image of a target object having a contour;
10 edge pixel extracting means for extracting edge pixels contained in said image;
orienting means for calculating the directions of said extracted edge pixels;
direction setting means for setting directions of straight-line portions contained in said contour;
line labeling means for setting a different one of labels to each of the directions of
15 said straight-line portions;
pixel labeling means for assigning to those of said edge pixels, which have the same direction as any one of the different directions of said straight-line portions, the same label assigned to said any one different direction; and
line segment extracting means for extracting, as a line segment, an assembly
20 consisting of those of said edge pixels which are continuous on said image and have a same one of said labels assigned thereto.

19. The image processing apparatus of claim 18 wherein said direction setting means comprises:
25 histogram making means for preparing a histogram from numbers of edge pixels having different directions; and
peak extracting means for extracting peaks from said histogram;
wherein said line labeling means sets a different label to each of the directions of edge pixels corresponding to a different one of the extracted peaks; and

wherein said pixel labeling means assigns each of the different labels set by said line labeling means to each of the edge pixels having the direction corresponding to the each different label.

5 20. The image processing apparatus of claim 19 further comprising unifying means for serving, if the line segments extracted by the aforementioned line segment extracting means include a pair with a positional displacement smaller than a specified maximum displacement value and a directional difference smaller than a specified maximum directional difference value, to unify said pair into a single unified segment.

10 21. The image processing apparatus of claim 19 further selecting means for selecting, from the line segments extracted by said line segment extracting, those of said line segments satisfying specified line segment selecting conditions.

15 22. The image processing apparatus of claim 20 further comprising selecting means for selecting, from the line segments extracted by said line segment extracting means and from the unified line segments unified by said unifying means, those of said line segments satisfying specified line segment selecting conditions.

20 23. The image processing apparatus of claim 21 further comprising display means for displaying positions of the line segments selected by said selecting means so as to be distinguishable on said image.

25 24. The image processing apparatus of claim 22 further comprising display means for displaying positions of the line segments selected by said selecting means so as to be distinguishable on said image.

30 25. The image processing apparatus of claim 21 further comprising display means for distinguishably displaying on said image positions of crossing points of extensions of a plurality of the line segments selected by said selecting means.

26. The image processing apparatus of claim 22 further comprising display means for distinguishably displaying on said image positions of crossing points of extensions of a plurality of the line segments selected by said selecting.

5 27. The image processing apparatus of claim 18 further comprising defect detecting means for determining whether a defect exists or not in straight-line portions of the contour of said target object by examining the line segments extracted by said line segment extracting means.

10 28. The image processing apparatus of claim 27 wherein said defect detecting means determines, if there is a pair of line segments among the line segments extracted by said line segment extracting means, said pair of line segments having directions of which the difference is within a specified range and having a positional displacement within a specified limit, that there is a defect between said pair of line segments.

15 29. The image processing apparatus of claim 27 wherein said defect detecting means determines that there is a defect in a straight-line portion of the contour of a target object by comparing the number of line segments extracted by said line segment extracting means with a specified standard value and if said number is different from said
20 specified standard value.

30. The image processing apparatus of claim 18 wherein said direction setting means inputs expected directions of the straight-line portions of the contour of said target object, said line labeling means sets a different one of said labels to each of the expected
25 directions inputted by direction setting means, and said pixel labeling means assigns said labels to those of the edge pixels having one of the expected directions inputted by said direction setting means.

31. The image processing apparatus of claim 30 further comprising unifying
30 means for serving, if the line segments extracted by said line segment extracting means include a pair with a positional displacement smaller than a specified maximum

displacement value and a directional difference smaller than a specified maximum directional difference value, to unify said pair into a single unified segment.

32. The image processing apparatus of claim 30 further comprising selecting
5 means for selecting, from the line segments extracted by said line segment extracting means, those of said line segments satisfying specified condition.

33. The image processing apparatus of claim 31 further comprising selecting
means for selecting, from the line segments extracted by said line segment extracting
10 means and from the unified line segments in said unifying means, those of said line segments satisfying specified condition.

34. The image processing apparatus of claim 30 further comprising defect
detecting means for determining whether a defect exists or not in straight-line portions of
15 the contour of said target object by examining the line segments extracted by said line segment extracting means.